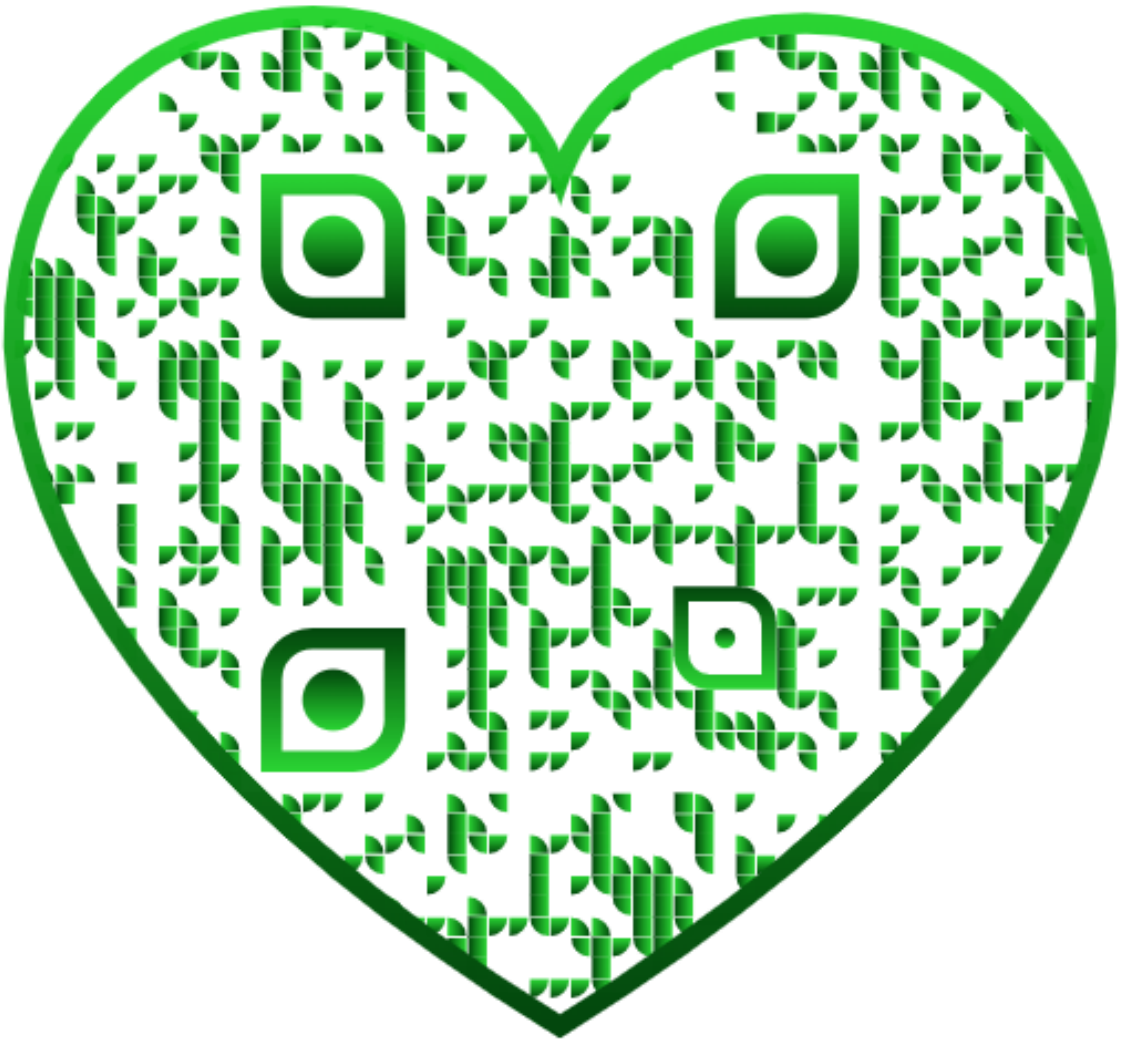
HYDROPONICS 101

- A Complete Guide

-Agnes Williams



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PREFACE

This book reveals the secrets behind growing plants Hydroponically using various systems. Hydroponics is the art of growing plants in water dissolved with nutrients – without soil. When I started a Hydroponic garden in my backyard, I was thrilled, and at the same time intrigued, by many questions that arise in the mind of a beginner. I had little help and resources to assist me with my new garden. The books I had bought about Hydroponics explained the principles scientifically. Even though I am a science person, and understanding things like ion exchange, ppm, and pH was easy, I did not want to spend time reading books that went to great lengths in explaining these concepts before relating them to Hydroponics. I wanted a book that helped me with my gardening. After a few false starts and working incessantly on growing my vegetables Hydroponically, I became an expert on the subject. But as I struggled to perfect the art of Hydroponic gardening, I thought, 'Why shouldn't other ardent lovers of Hydroponic gardening benefit from my expertise?' And I started writing this book!

This book explains how to easily grow plants Hydroponically. For all those readers who do not like Science / Chemistry, I have unfortunately included a few scientific terms but I have managed to keep them short and simple. This book attempts to explain Hydroponics in layman terms, and for a novice, it is recommended that you to read this book throughout.

Hydroponics is a system of growing plants without SOIL. Plants are grown using nutrients supplied through water, and lighting is provided to help the plants' growth. Many gardeners are beginning to realize the value of Hydroponically grown vegetables, greens and flowers. Hydroponics quickens the growth process thereby yielding crops of better quality and quantity and quicker. Hydroponically grown plants are not dependent on the weather; you can grow them during all seasons of the year. The products are more nutritious and rewarding than their soil-grown counterparts. Soil-grown plants depend on microbes and thousands of other micro-organisms to provide them with nutrients. Pull out any plant, thoroughly wash it and check the roots under a magnifying glass – you can still see microbes attached to the plant's roots. A damp environment is the ideal place for anaerobic bacteria to grow; this is where plants begin to deteriorate.

This problem is eliminated in a Hydroponic system.

The first chapter is an Introduction to Hydroponics with a discussion on the history, current use and future use. We have found evidence of the use of Hydroponic systems in ancient civilizations such as the Aztecs, the Egyptians and the Babylonians. The famous 'Hanging Gardens of Babylon' used Hydroponics. However, it was not until World War II that Hydroponics was tested for the first time. Hydroponics prompted the idea of 'Aeroponics' where small plants, which need no physical support, are grown by misting the roots suspended in air. In this chapter, you can begin to understand the principles of Hydroponics and the various systems used; it also covers the environmental requirements for a Hydroponic system.

Anyone trying to build a Hydroponic system knows that selecting a system suitable for their situation is half the battle. The second chapter focuses on selecting the right Hydroponic system for your situation; it gives you an idea about your situation and how to choose the right system for your needs. Each Hydroponic system is unique and can grow specific vegetables exceptionally well. An important aspect to an efficient Hydroponic system is correct lighting. Many plants grow based on the duration for which they receive sunlight / artificial light. Roses, for example, bloom on a 12-hour light and 12-hour darkness cycle. By controlling this lighting pattern, you can have your roses bloom earlier! To reduce the task of discovering which plants grow well with which system, this chapter provides you with a list of vegetables that can grow well with each system, and also provides a list of vegetables suitable for specific areas of the country.

Your plant is only as good as the seed / clone you select for germination. Seeds make a significant contribution to determining the quality of your plants and produce. The third chapter teaches you to choose the right type of seeds for germination and the nutrients to help plant growth. Nutrients make a vital contribution in boosting the growth phase, as you need to mix the nutrients accurately and balance the pH for ideal growth results. Many people are put off by the thought of mixing nutrients and checking for pH value. It might sound daunting to some of you at first, but it is not as complicated as it sounds. You can also find useful information about USDA Hardiness zones and indexes.

The next step after getting good-quality seeds is to sow them, provide nutrients and light; the final step is harvesting your produce. All these topics are covered in the fourth chapter. Here, you can learn how to set up your drip-feed system; you can also learn about growing herbs using Hydroponics, and going commercial with your herbs!

Any type of gardening – soil or soil-less has its problems. The last chapter (fifth) addresses all your concerns, and provides some remedies for you. By the time you finish reading this book, you should be better equipped to handle your garden efficiently. If you are an advanced user already and are thinking about taking your hobby to the next level – business – then there is a section for you too. There is an explanation of when and how to develop a bigger system; you can also find information concerning system upgrades and transplanting.

It also explains the various Hydroponic systems in use and how to assemble them. Tasty vegetables, good-looking roses or leafy greens are a result of using high-quality seeds for germination. You can also alter the genetic pool of these Hydroponically grown plants to yield better results in the long run. Many people wrongly assume that Hydroponically grown plants are not organic; this arises from ignorance of the science involved in Hydroponics. As you go through this book, you might be amazed to learn that Hydroponically grown plants have a healthier and cleaner environment than their soil counterparts.

1 A BEGINNER'S GUIDE

In This Chapter

- The right growing location
- Grow room essentials
- Choosing the right hydroponic method of growing
- Lighting
- Testing equipment
- Proper ventilation

When Growing with hydroponics it can be a little overwhelming at first, but in this beginner's guide you will learn exactly how to achieve maximum yields with ease.

Hydroponics have progressed into a fun and interesting way to grow your favorite fruits and vegetables, and also very effective compared to soil growing.

Here is a simple checklist to keep in mind when starting out in hydroponics or already growing with hydro systems.

THE RIGHT GROWING LOCATION

Having the right environment to grow in is imperative to your success. You want to grow in a room where the temperature is stable to your desired crop temps and humidly is relative to what you are growing as well. Some plants like high humidity and high and some don`t, when growing with hydroponics check the conditions in which your plants thrive in, and then simulate.

CHOOSING THE RIGHT HYDROPONIC METHOD OF GROWING

This is going to be an important decision and to most people starting off, a very confusing one, but by all mean isn't the least bit confusing. This purely depends on your knowledge of the systems and your personal preference. For growers first starting

off with hydroponics a deep water culture system is often recommended, as it is very easy to understand and operate. But really most hydroponic systems require minimum knowledge to work with. I would recommend going through the hydroponic system types outlined in this book and find out which one that would be best for you.

LIGHTING

Now you need to make sure you are going to have a sufficient amount of lighting for your grow room. Having inadequate lighting will hinder your plants ability to grow to their full potential, and in some cases stop growing all together.
Here is a simple list of the most common wattage output of most grow lights and their expected areas of coverage.

- 100Watts = 2' x 2'
- 250Watts = 3' x 3'
- 400Watts = 4' x 4'
- 600Watts = 5' x 5'
- 1000Watts = 6' x 6'

Follow this rough guide when deciding on your lighting you will be using.

Furthermore, one kind of light witch may be typical for one grower may not be the right choice for another. For instance HID (high intensity discharge) lighting is a popular choice and in most cases the right one for medium to large grows because of their large light output. But having this kind of lighting in a small grow space could burn your plants and kill them rather quickly. For a smaller setup regular fluorescent or CFL (compact florescent light) are perfect because these lights stay very cool and are able to be situated a few inches from your plants, if needed.

TESTING EQUIPMENT

You absolutely need some types of testing equipment when growing with hydroponics. Among the testing tool you will need are a Ph meter, PPm meter, Ec meter, Temperature gauge and humidity gauge. These are imperative to a successful grow as sometimes with all hydroponic growing one time or another will experience irregularities and have to test certain aspects of your system to find and fix the problem.

PROPER VENTILATION

When growing indoor you have to be able to create a continuous exchange of fresh air entering your grow room and expelling spent air outside the room. This is achieved by have no less the 1 fan blowing air outside the room and 1 blowing inwards. This part will require a little ingenuity that depends on the specific grow room. A room with

windows can achieve this very easily by simply installing the fans by the window, one sending air in and one sending out. But with most grow room you will have to run 2 sets of ventilation ducting going outside of the room, with the corresponding fan inside the ducting. This is very easy to understand and with some common sense you can accomplish a great ventilation system.

Just follow this advice and basic guidelines and also keeping this in mind when read the rest of this book. Everything we covered here goes hand-in-hand with what is going to be discussed in the next chapters

2 INTRODUCTION TO HYDROPONIC SYSTEM

In This Chapter:

- What is a hydroponic system?
- Pros and cons of hydroponic farming
- How does a hydroponic system work?
- Schematic representation of a hydroponic system
- Environmental and nutritional Requirements of a hydroponic system
- Selecting a good indoor grow space and setting up

The term Hydroponics derives from two Greek words – 'hydro' meaning water and 'ponos' meaning labor. Hydroponics is the art of growing plants without soil. Most farmers in ancient times believed that soil provided only support to plants and it was water that helped plants grow – this was because their crops perished if the rains failed.

Apart from providing support to plants, soil is also a breeding place for millions of microbes – both aerobic and anaerobic. Aerobic microbes are those that help in the growth of plants; anaerobic microbes are those that cause plant decay.

Using a Hydroponic system, we can eliminate the presence of anaerobic microbes; the contribution normally made by aerobic microbes is now performed by supplying nutrient solutions.

WHAT IS A HYDROPONIC SYSTEM?

A system that provides the essential elements for successful plant growth, without using soil as a growth material, is called a Hydroponic system. The essential elements are:

- Nutrient solution
- Proper exchange of gases
- Lighting
- Growth / Support material like Perlite, Rockwool, coconut coir, and so on.

The ancient Babylonians, the Aztecs and the Egyptians are said to have used Hydroponic irrigation to grow plants; the famous 'Hanging Gardens of Babylon' is one such example. Experiments in Hydroponics started in 1936 – Dr. Gericke from University of California, Los Angeles, successfully grew tomatoes in water culture. During World War II, Hydroponics was used to grow plants in non-arable areas. However, it was not until the 1970s when farmers and gardeners started showing interest in Hydroponics. But, even to this date, the potential of Hydroponics is not used to its fullest; many gardeners are still unfamiliar with the terminology.

Currently, Hydroponic systems are used to grow a variety of plants such as lettuce, green pepper, lettuce, basil, and so on. The Hydroponic system of cultivation is seen as a possible solution to the hunger problems of the world. The beauty of this system lies in its simplicity. You can use your garage, rooftop or any available space to grow plants. Continual research and development has led to the use PVC material that is reusable and long lasting; Middle Eastern countries, where water is a scarce resource, are adopting Hydroponic system for cultivation. Huge buildings with desalination systems are built to help in crop cultivation. The future of Hydroponic cultivation is getting brighter by the day and it would not be a surprise to see this method of cultivation becoming the norm!

PROS AND CONS OF HYDROPONIC FARMING

Hydroponic farming is embraced by many people all over the world and as mentioned before, it has a bright future. However, before you consider getting into Hydroponic farming, you must consider all the pros and cons of such a system.

PROS:

- You can grow good-quality crops in a smaller space such as your garage, backyard, or condo balcony.
- The nutrient solution supplied to plants can be altered to suit the various growth stages; this gives us better control over the plants and crops.
- Hydroponic gardening does not need soil preparation before sowing seeds; it does not require you to pull out weeds or water them.
- Nutrient solution can be recycled thereby reducing pollution
- You can avoid soil erosion, soil-borne insects and pests in Hydroponic gardens
- Transplantation shock in seedlings is reduced

CONS:

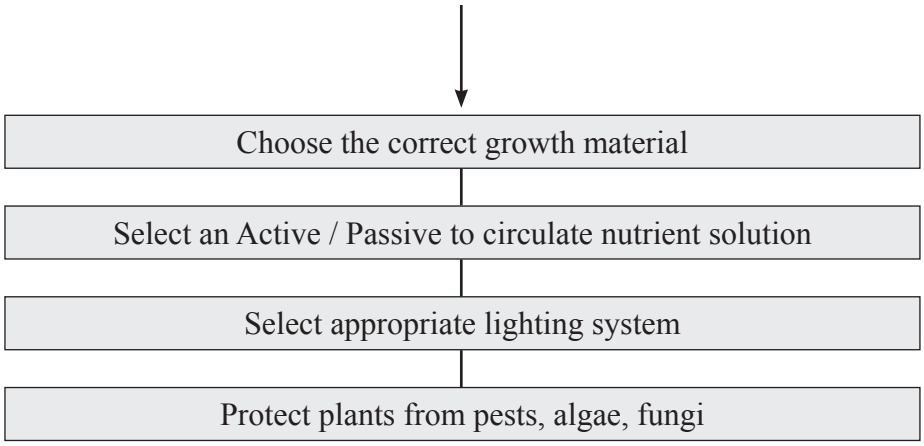
- Initial set-up cost is high
- You must understand the basics behind nutrient solution, cultivation and harvesting of crops
- Ideal moisture control, lighting and oxygen level must be present always in a Hydroponic garden. Even a slight imbalance in any setting can cause irreversible plant damage

HOW DOES A HYDROPONIC SYSTEM WORK?

A Hydroponic system must satisfy three basic requirements for plants to grow and survive:

- Efficient supply of water and nutrients
- Protection for plant roots from dehydration in the event of a pump or power failure
- Maintenance of proper gas exchange levels between roots and nutrient solution

SCHEMATIC REPRESENTATION OF HYDROPONIC SYSTEM:


Choose the correct growth material
Select an Active / Passive to circulate nutrient solution
Select appropriate lighting system
Protect plants from pests, algae, fungi

Seed selection has a significant effect when deciding on the taste, flavor, color and texture of your produce. If your neighbor grows tasty and juicy tomatoes in the backyard, your best bet is to get seeds from their plants to get the same results. When plants grow outdoors, nature introduces genetic material that alters the result. When you grow plants indoors, you can introduce the same genetic material to grow produce according to your choice. You can alter or retain the same genetic coding in your next generation plants to maintain good quality.

Soil material in Hydroponics is replaced with loose growth / support material to drain nutrient solutions quickly. If you have a system that recirculates nutrient solutions frequently, use a material that drains the solution quickly. If you have a system where recirculation of nutrient solution is minimal, use a slow draining material. Apart from efficient draining, maintaining a good nutrient to air ratio is important. You can combine various materials to achieve high draining efficiency while maintaining a good nutrient to air ratio.

Based on your nutrient circulation method, you can either opt for an active system or passive system. An active system uses mechanical pumps to circulate nutrient solution and air; you can use timers to water your plants. A passive system is a closed system

where nutrient solution is not recirculated. You can buy nutrient solutions or prepare it at home. When you prepare nutrient solution, care must be taken to use an accurate measuring system, and check and balance the pH frequently.

Plants require light for photosynthesis – a process that provides food for plants to grow. In outdoor gardening, this light is provided by the Sun. With indoor gardening, you must provide alternate sources to help photosynthesis in your plants. This can be provided using HID – High Intensity Discharge lighting. HID lamps provide maximum PAR (Photosynthetically Active Radiation) for the amount of power consumed. As a rule of thumb, 20 to 50 watts lighting is required for every square foot.

An indoor garden is free of many pesticides that are used outdoors. Also natural elements, such as rain, water and wind that keep the outdoor plants pest free, are absent in indoor gardening. However, one of the easiest ways to combat pests in your indoor garden is to keep it clean from dust and debris. Avoid going near your plants with unclean slippers. Keep a separate toolbox needed for your gardening and always remember to clean your tools with 10% bleach solution. Molds and mildew thrive in damp and humid atmosphere. Therefore, good air circulation is required to remove excess humidity. Maintaining excellent air quality is important to stop spores in the atmosphere from forming fungi. The indoor growing area must be clear of dust and debris. Maintaining correct watering levels is vital with indoor gardening. Humidity must be maintained between 60% to 80% and air must be continually circulated in the garden.

ENVIRONMENTAL AND NUTRITIONAL REQUIREMENTS OF A HYDROPONIC SYSTEM

Plants also need nutrition and a favorable environment to grow. Fortunately, with a Hydroponic system, we can create an almost ideal system for plants to grow to their potential. In a Hydroponic system, plants do not have to struggle to find nutrients, instead it is readily supplied to them. This helps plants utilize their energy toward growing and yielding favorable produce.

Every plant species is unique and thrives under specific environmental conditions. For example, cactus is a desert plant and grows and thrives under desert conditions. If you try to grow cactus in a cold region, it might grow but does not thrive. The same is true with nutritional requirements. These requirements vary based on the species. A tomato plant, for example, needs more nitrogen during the growing stages and less nitrogen during the fruiting stages. You can control the nutritional requirements by tweaking your nutrient solution accordingly.

ALL ABOUT NUTRIENT SOLUTIONS

As you may already know, nutrient solutions provide all the necessary nutrients for the plants to grow. You can prepare your nutrient solution at home. However, before you

proceed to prepare the solution, you must understand plants' basic nutrient requirements.

Plants need two types of nutrients:

- Micro-nutrients
- Macro-nutrients

Micro-nutrients

Micro-nutrients are trace elements found in plants that are essential for their growth. Here is a list of micro-nutrients, their functions and problems caused because of deficiency and excess production.

Sulfur (S):

Required for: Seeding, Fruiting, protein synthesis and is a natural fungicide
Deficiency causes: Yellowish leaves and purple base
Excessive production stunts growth

Iron (Fe):

Required for: chlorophyll formation, sugar respiration to provide energy for growth
Deficiency causes: blossoms to drop from plant, yellowish color appears between the veins and leaves die at the margins
Excessive production is rare and difficult to spot

Boron (B):

Required for: formation of cell walls
Deficiency causes: poor growth and brittle stems
Excessive production may cause leaf tips to turn yellow and die

Manganese (Mn):

Required for: oxygen production during photosynthesis
Deficiency causes: Blooming fails and yellowish color appears between the leaf veins
Excessive Mn reduces Iron availability to leaves

Molybdenum (Mo):

Required for: Nitrogen metabolism and fixation
Deficiency causes: cause small yellow leaves
Excessive Mo causes leaves to turn bright yellow

Copper (Cu):
Required for: photosynthesis and respiration
Deficiency causes: leaves with yellow spots
Excessive Cu reduces the availability of Iron

Macro-nutrients:

Macro-nutrients are those that are consumed in large quantities by plants. In regular gardening, these nutrients are provided by the soil, microbes, sunlight, rain water and fertilizers; in Hydroponics, we must provide these nutrients through nutrient solution. Here are the four essential nutrients that occur naturally:

- Oxygen
- Nitrogen
- Carbon
- Hydrogen

Oxygen: required in the respiration process and helps the formation of sugar, starch and cellulose.

Nitrogen: Amino acids – the building blocks of cells – are formed using Nitrogen. Nitrogen also helps the formation of chlorophyll.

Carbon: Half the dry weight of plants consists of carbon. It is essential for the formation of chlorophyll.

Hydrogen: Plant roots absorb nutrients through a process called cation exchange. Hydrogen makes a significant contribution in this exchange and in the production of sugar and starch.

Apart from the above four nutrients, **Potassium** and **Phosphorous** also are major contributors toward plant growth. Potassium is necessary for protein synthesis and root growth. Potassium deficiency leads to fungal infection in plants. Phosphorous is a necessary element in the cells; it is present as ATP (Adenosine Tri-Phosphate). Phosphorous deficiency leads to stunted growth whereas excess phosphorous reduces the availability of copper and zinc.

NUTRIENT SOLUTION AND PH

The pH value gives us a measure of the Hydrogen ion concentration in the nutrient solution. pH value is measured on a scale of 0 to 14.

- pH 7 – neutral
- ph <7 – acidic
- pH >7 – alkaline

A single pH value does not suffice the requirements of all the plants. Each species of plant has its pH value. A pH of <4.5 or >9.0 can adversely affect plants; in these cases, essential nutrients are locked in the solution because of extreme toxicity or alkalinity. Therefore, availability of nutrients to your plants is directly related to the pH value. An ideal pH value lies in the range of 6.0 to 7.5.

Plant names	pH range
Tomatoes	5.8 – 6.0
Lettuce	5.7 – 6.2
Eggplant	5.7 – 5.9
Peppers	5.8 – 6.2
Beans	5.8 – 6.2
Strawberries	5.8 – 6.2
Melons	5.4 – 5.6

The material used to grow your plants, such as saw dust, peat moss, or vermiculite, can also change the pH of nutrient solution. So it is a safer to use material that does not alter the pH of nutrient solutions, such as Perlite, Rockwool, expanded clay, or coconut coir.

TYPES OF NUTRIENT SOLUTIONS

Nutrient solutions can be single-part, two-part or three-part. Single-part solution is more generic and can be used on a variety of Hydroponically grown plants; they can also be used during various growth stages. Because a single-part solution cannot be customized to meet your plants' growth stages, it is advisable to use two-part or three-part solutions.

In a two-part or three-part solution, you can blend the nutrients to suit the needs of your plants. Nutrients needed at various growth stages are different. By providing the correct nutrients at various stages, you can reap good produce. The need to balance the concentration of nutrients in your solution cannot be stressed enough. Hydroponically grown plants depend only on the nutrient solutions to grow. Any changes in the nutrient concentration level can lead to disastrous results.

GROWTH MATERIAL

The necessity of using soil is eliminated in Hydroponic gardening. Soil – apart from supplying nutrients also provides support as plants grow. In a Hydroponic system, this support is provided using various materials like Perlite, Rockwool, expanded clay pellets, coconut coir, vermiculite, grow cubes, sawdust, lava rock, and so on.

PERLITE:

Perlite is a naturally occurring volcanic glass that can expand immensely when heated to its softening point; it can expand up to 20 times its original size. Perlite is lightweight and can be used on its own or as part of soil-less mixture. It is usually mixed with vermiculite in equal quantities.

Advantage: Provides good drainage and aeration to plants; best material for a wick-type Hydroponic system

Disadvantage: The dust from Perlite is known to cause irritation; it is recommended to wear masks before handling Perlite.

ROCKWOOL:

Rockwool derives from melting basalt rock at high temperatures; the resulting fibers are spun and compressed into cubes, bricks or slabs.

Advantage: Rockwool is a good material to plant seeds because it is immune to microbes; it has good absorption and aeration capacity.

Disadvantage: It is not environmental friendly; the dust is known to cause irri-

tation. It alters the pH of nutrient solution – extra care must be taken to maintain correct pH.

COCONUT COIR:

One of the most efficient materials to use in your Hydroponic system, and it is also known by such names as 'Coco-tek', 'Cocopeat' and 'Ultrapeat'.

Advantage: Coconut fiber is a completely organic material that has excellent water and air retention properties.

Disadvantage: Starts to break down after several uses; does not have good drainage properties – better to mix with other materials to maximize results.

EXPANDED CLAY PELLETS OR LECA:

LECA – Lightweight Expanded Clay Aggregate is made by heating clay or slate at high temperature till it puffs up like popcorn.

Advantage: pH neutral, reusable, odorless, good water drainage capacity

Disadvantage: Poor moisture retention capacity – better to mix LECA with other materials

VERMICULITE:

Vermiculite is a mineral that expands when heated because of inter-laminar heat. It is rarely used on its own; usually it is combined with other growth materials especially Perlite.

Advantage: Retains water, moisture and nutrients

Disadvantage: Poor drainage capacity

CHARACTERISTICS OF A GOOD MATERIAL

- is environmental friendly (biodegradable)
- helps safeguard plants against pH changes
- can contain equal ratio of water and air
- can be hydrated easily after dehydration during storage
- is compatible for both indoor and outdoor use

SELECTING A GOOD INDOOR GROW SPACE & SETTING UP

When finding a good area to grow indoors there is a few key characteristics to look for in the room. The first obvious decision is picking a room with more than enough space to accommodate your type of growing operation, the more room to work with the better. One thing to look for is a window for ventilation purposes; this will save you a lot of hassle of running ventilation ducting throughout your house. Next you want to try to find a room on a ground floor, this way you won`t get higher temperatures as a 2nd or 3rd floor or the common humidity problems that plague basements. And also a room with some kind of water source access would be a plus.

Now once you`ve selected your room you want to get it all ready for your incoming hydroponic grow. You can start off by giving the room a good cleaning from top to bottom.

The next thing you want to do is get your ventilation set up. This is all depending on the room. The traditional way is to run 6 inch to 12 inch ventilation ducting near your light source and another near the floor for incoming fresh air, run both of these all the way out of your room preferably somewhere outside the building. I recommend installing some ducting fans also, one of incoming air and one for outgoing. Or you have a window you can do this simply by leaving it open when temps are nice outside, this is called a passive ventilation system. And always you want to have at least one fan osculating throughout the room for adequate air exchange.

Now you have a basic room ready for an indoor grow.

3 TYPES OF HYDROPONIC SYSTEM

In This Chapter

- Passive systems
- Active systems
- How to build your own hydroponic systems
- Lighting requirements
- Maintenance

There are many types of growth boxes / systems to help you with your Hydroponic gardening. You can either opt to grow your plant in a small bucket before moving to a bigger growth box, or go for a system where you can start to cultivate your crops on large scale. A growth system can either use a material such as Perlite or Rockwool, or use NO growth material at all. You can build two types of system based on the delivery method of nutrient solutions:

- Passive system
- Active system

PASSIVE SYSTEM

In a passive system, the plants' roots are in touch with the nutrient solution and the plants are supported using suspension. The principal disadvantage of this system is that it is difficult to support your plants as they grow. However, a passive system is a basic system and is easy for a beginner to set up. This system is portable and inexpensive. An example of a Passive System is:

Wick System

A wick system uses a lamp wick or wick made of nylon, polyester or rayon to supply nutrient solution to the roots. Commonly used growth material are vermiculite, Perlite or LECA.

A pot is supported above the nutrient tray solution and a wick soaked in nutrient solution is passed through the drainage hole into the nutrient tray. You must

leave 10 cm of the wick inside the pot and ruffle the ends for better circulation of nutrient solution.

ACTIVE SYSTEM

Active systems are more efficient and productive; they use pumps to supply nutrient solutions to the plants and a gravity system to drain off excess solution, which is then reused. Various types of materials can be used to act as a quick drain system, such as Perlite, Rockwool, expanded clay pebbles, or coconut coir. If you are using coconut coir, a higher air holding ratio can be achieved by mixing equal volume of Perlite with the coir.

The principal difference between an active and passive system is that an active system uses pumps to supply nutrient solution whereas a passive system uses a wicking action to draw nutrient solution.

TYPES OF ACTIVE SYSTEM:

The following are the various types of active system:

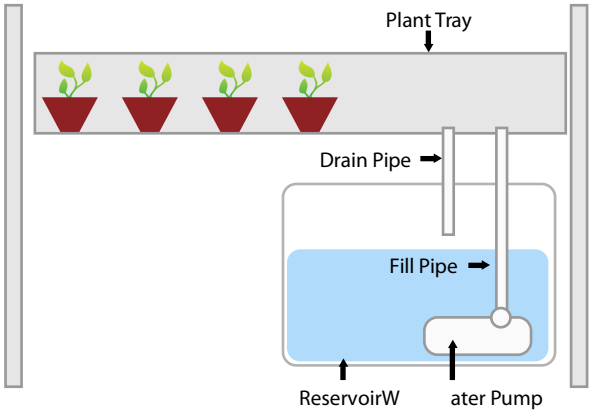
- Ebb and Flow system
- Nutrient Film Technique
- Drip System or Top Feed
- Aeroponics
- Dutch Bucket Method
- Raft Method

Ebb and Flow System

An Ebb and Flow System is also called a flood and drain system. Maintenance and set-up is not expensive and hence is a popular system.

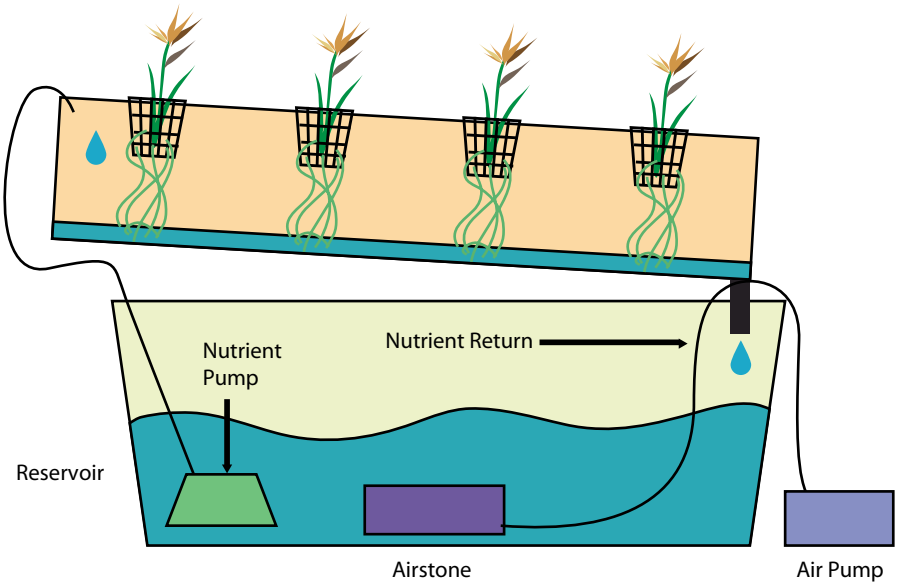
Both long-term and short-term produce grow well in this type of system. Here, the nutrient solution can flood the material for 15 minutes every hour or two. Popular growth material is expanded clay pebbles, Perlite or Rockwool.

Ebb and Flow system can be automated using a computer. There is a uniform distribution of nutrient solution to all the plants in this type of system.



Nutrient Film Technique

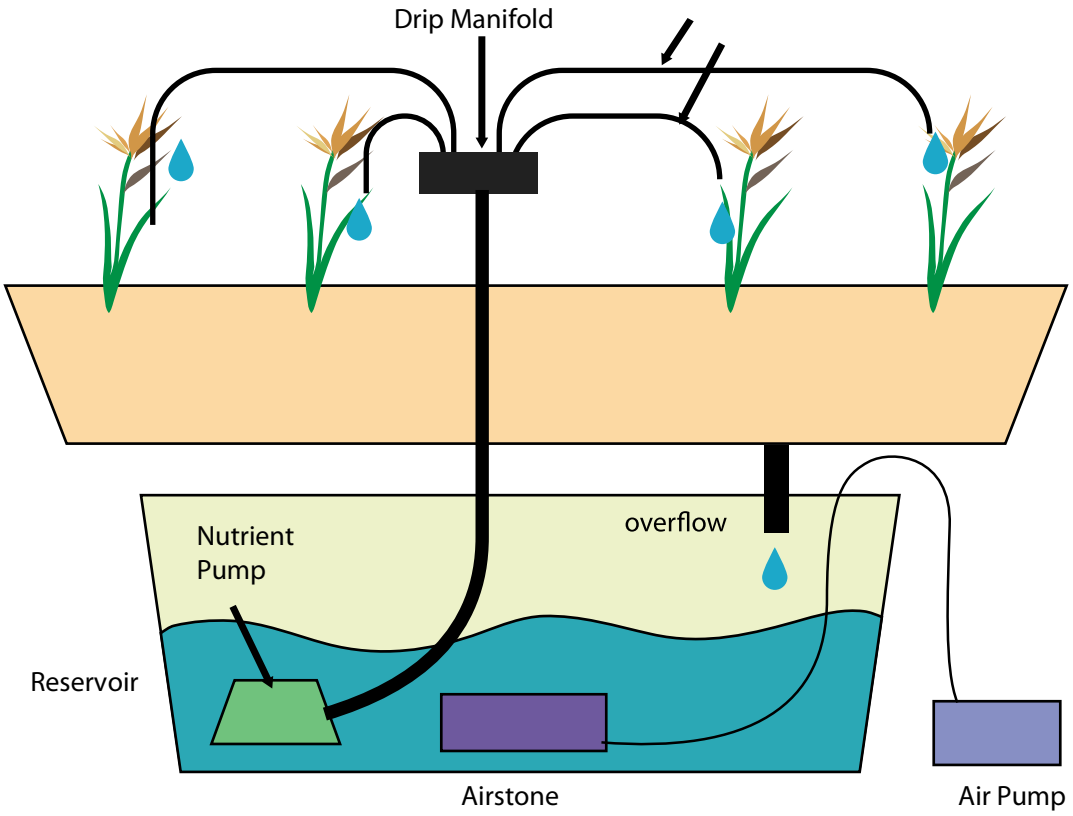
This system uses an automated pump and reservoir system to supply and recycle nutrients. It is possible to grow more produce using this system. Plants are placed in an enclosed inverted 'V' shape channel, but as a result, plants can suffocate and die because of lack of oxygen.



Problems also arise if there is a power failure or equipment failure. This system is primarily used by lettuce growers. If you are a herb lover, use NFT to grow them; you will love the results!

Drip System or Top Feed System:

One of the principal advantages of this system is that it can withstand short-term power / equipment failure. Rockwool is used as the material here. Nutrient solution is dripped onto the plants and the remaining solution is drained back to the reservoir. Supply of nutrient solution is timed. It is expensive and difficult to set up a drip system. However, it is popular among tomato and pepper growers.



Aeroponics

A recent development in which plants are suspended in midair and are supplied with nutrients. Nutrients are sprayed to the roots; their exposure to air provides them with maximum oxygen. In this system, supply of nutrients and oxygen is maximized. Care has to be taken to maintain 100% relative humidity. The principal drawback to this system is the functioning of pump and reservoir in the event of power failure. It is expensive to set up this system and is more often used in laboratory studies.

Dutch Bucket Method

This system was first used in the Netherlands to grow tomatoes, cucumbers and roses. This uses a bucket (2.5 gallon) that holds nutrient solution at the bottom of the bucket. A pump is used to recycle the nutrient solution.

Raft Method

In this method, Styrofoam sheets are used to float plants fixed in baskets on top of nutrient solution. Usually, short term crops are cultivated using this system. The problem of stagnation is solved by circulating air from bottom. This system is used for lettuce production and to cultivate other greens.

HOW TO BUILD YOUR OWN HYDROPONIC SYSTEM

You might want to build your own system. One of the main advantages of making your own system is that you can customize. It is also easy to build.
Here you have three alternatives to consider.

Deep water culture

In this DIY guide we will show you step by step how to construct a simple Deep water culture system for 6-12 plants. This type of system is very easy to construct even for a beginner.

MATERIALS NEEDED

- Air pump 3+ watts
- 12 inch Air stone
- air tubing a few feet will do
- 18 gallon tote(Rubbermaid) container with lid, this will be the reservoir
- 6-12 3 inch net pots
- Clay pellets growing medium-1.5 liters per net pot
- Rockwool cubes
- Marker
- Box cutter
- Power Drill with ½ drill bit
- Hydroponic nutrients

INSTRUCTIONS:

First thing you need to do is figure out where the net pots are going to be positioned. Use a marker to make some 3 inch circles where the net pots are going to go. After this is done start cutting the holes out with a box cutter.

Now that this is done set the lid aside and start washing out the tote, preferably with 5%-10% bleach to 90%-95% water mixture.

Now drill a small ½ inch hole at the top of the tote by the handle part, make sure it is close to the top so water won`t escape out. This hole is where the tubing from the air pump will go.

Now measure some tubing from where the air pump will be outside the system all the way through the hole you drilled and to the bottom of the tote. Now cut the piece of tubing and connect one end to the air pump and run through hole and connect air stone to other end and place air stone on bottom of tote.

Now you can fill with water. Try to fill well below where you drilled hole, you can add or subtract water later on if needed. Next add desired nutrients to water, follow the directions that came with the nutrients carefully. *optional, run pump overnight to evaporate chlorine is water source is known to contain chlorine.

Next install the net pots to the holes in lid, they should fit nice and snug. Fill the net pots with clay pellets. After this is done put the lid on the tote and make sure the bottoms of the net pots are submerged in the nutrient solution.

I recommend first starting plants in rockwool cubes then transplant into the net pots filled with clay pellets. But your starter medium of choice should be fine.
That's it; you now have a fully functional deep water culture hydroponic system.

Drip feed system

This how to guide will show you how to construct a simple 4 plant drip feed hydroponic system.

MATERIALS NEEDED

- 5-8 gallon square bucket with a lid
- Small submergible water pump 105 GPH will do
- air pump
- 6 inch Air stone
- 5 feet of ¼ inch drip tubing
- 3 "T" connectors for the drip tubing
- 3 feet of ¼ inch air tubing
- Four 3 inch net pots
- 1 ½ pounds of clay pellets hydroponic medium
- Box cutter
- Drill for drilling holes
- Hydroponic nutrients

INSTRUCTIONS

Start out by tracing four, 3 inch diameter circles on the lid where the net pots will go. Next using a box cutter carefully cut out the holes. Now drill a ¾ inch hole directly in the center of the lid, this be for the drip tubing. And now drill a 1 inch hole near the edge of the lid; this will be used for the power cord running form the water pump and air tubing coming from the air pump.

Next place the water pump at the bottom of bucket, running the power cord through the 1 inch hole, and connect one end of drip tubing to it. Run the tubing on the side of the inside of the bucket and through the middle hole, and cut the tubing once a little outside the hole on the lid. Connect one of the T connectors to this. Now measure and cut 2 pieces of tubing that will run from both ends of the T connector to the middle of where the 2 net pots on each side will go. Place the remaining 2 T connectors on each end. Now cut 2 small pieces of tubing for each side of the connectors, so that they are just long enough to reach the center of the net pots.

Now connect one end of air tubing to the air pump and run the tubing from the air pump through the 1 inch hole and to the bottom and cut. Now on this end connect to the air stone and place on bottom.

Insert net pots into cut holes and add growing medium, which will be clay pellets in this case. Fill container with water/hydroponic solution mix. Fill up until the bottom part of the net pots are fully submerged in the water.

Now all you have to do is plug everything in and add seedling to the net pots and you're done. I suggest starting seedlings in rockwool cubes or oasis cubes and then transplanting to the net pots with clay pellets.

Ebb and flow

An ebb and flow system is an easy system to construct and any type of water pump is optional and not needed, with is totally unique then other systems, while still achieve optimal results.

MATERIALS NEEDED

- Two 15-20 liter containers, buckets or Rubbermaid tots
- Growing medium: I suggest all clay pellets or a 50/50 mix of perlite and vermiculite
- Large gravel rocks or a few liters of clay pellets
- 3 meters of flexible tubing, any tubing intended for irrigation will do
- 2 tubing joints
- 2 tubing grommets
- 1 table: a generally medium sized table will do, as long as it is big enough to accommodate the 2 buckets
- hydroponic nutrients
- Drill to make holes
- Silicone

INSTRUCTIONS

First off you want to use a drill and make a hole on the side near the bottom of both of the buckets, making sure the diameter is the same as the inside of the grommets that you will be using to connect the tubing and joints. These holes should be around 3-5cm above the bottom on each bucket.

Now insert the grommets into the holes you`ve just made, make sure that it is a tight fit, if done correctly this should be somewhat water tight. I recommend apply silicone around the holes before inserting the grommets to make sure that it is 100% water tight. Let this sit until silicone is completely dry.

Now connect the 2 joint pieces to each end of the irrigation tubing and insert each end of the tubing into the grommets of each bucket.

Now connect the 2 joints to each end of the irrigation tubing and then insert each end into the grommets on each bucket. Now the 2 buckets should be connecting together by the tubing.

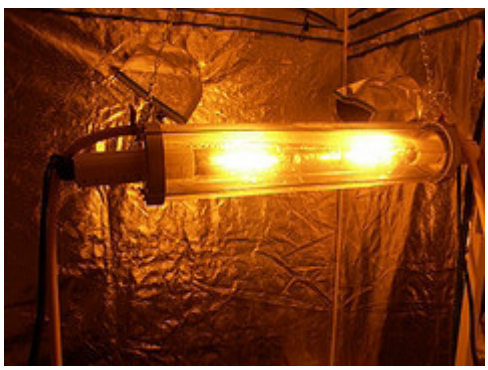
Now use the gravel rocks and fill one of the buckets just enough to cover the bottom hole, this is imperative so no perlite or vermiculite will clog up in your tubing. Now that this is done add your growing medium of choice to the same bucket and fill until it is about 6cm from the top.

At this point you can add your seedling in the growing medium. After this is done fill the other bucket with water and hydroponic nutrients to about 6cm or lower from the top.

Now you are done. Your bucket that you will be growing in should always remain on the table and to flood system place other bucket on table and water will be transferred to growing bucket. To drain place same bucket under the table, simple enough right? You should flood your system approximate 5 times a day for 20-30 minutes at a time, and then drain accordingly.

LIGHTING REQUIREMENTS FOR HYDROPONIC SYSTEM

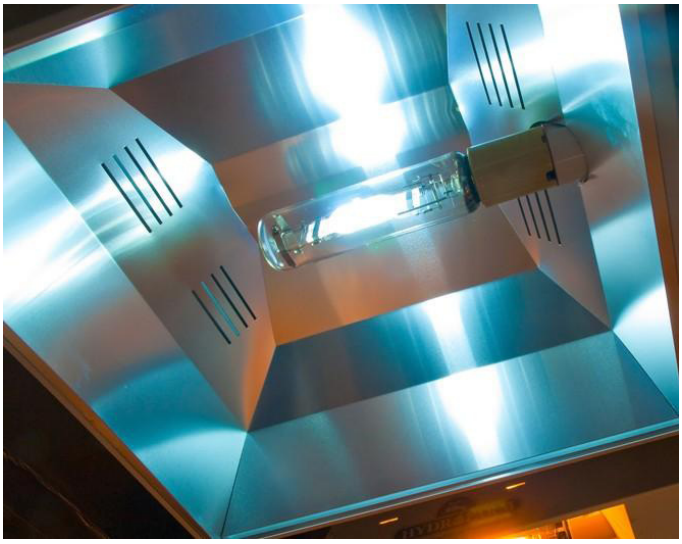
Sunlight is essential for plants' growth. Sunlight provides the energy for growth, germination, flowering and photosynthesis. In Hydroponic gardening, sometimes natural light is absent or difficult to provide. To overcome this drawback, we provide light to the plants through artificial means using artificial lighting. Usually lighting is provided for 16 to 18 hours every day to optimize growth. Care must be taken to provide complete darkness for the remaining duration of 6 to 8 hours. Specific plants like roses have 'photoperiodism' – meaning, the flowers bloom depending on the length of daylight.



There are many types of lighting available:

- Fluorescent tubes
- Incandescent lights
- High Intensity Discharge
- Metal Halide
- High Pressure Sodium

Fluorescent tubes are low wattage bulbs that emit low-temperature light. This lighting is most suitable for the first two weeks of a plant's life. Thereafter, the intensity and heat generated from fluorescent lighting will not suffice for plants' lighting requirements.



Incandescent light bulbs emit light and an equal amount of heat; they are expensive to operate and are not healthful for plants' growth. You may consider converting incandescent bulbs into growth light bulbs by coating the inside – but it seldom works!

HID – High Intensity Discharge lighting is the most economical way to provide lighting for your plants; it is also the safest way. You can find HID lighting in parking lots, playgrounds, and at places that need high efficiency at low cost.

Blue-white spectrum is best suited during the vegetative phase of a plant's growth; this is provided by **Metal Halide lighting.** This lighting helps the formation of strong leaves, stems and branches. If you are planning to have only one lighting system for your Hydroponic garden, this is the best choice.
Best Suited for: Roses, Zinnias, Marigolds, Chrysanthemums, and Geraniums

During the flowering and fruiting phase, red spectrum light is most favorable for plants. You can provide this lighting through **High-Pressure Sodium** lamps. This lighting is usually used with Metal Halide lighting. Herbs like dill and coriander grow well under this light, and this light is primarily used in commercial greenhouses.
When using HID lamps, the spacing must be 12 to 14 inches from the plants for 250W and 16 to 24 inches for 1000W lamps. Walls are usually painted with light reflective coatings to increase the diffusion of light. Some common wall treatments include:

- Aluminum foil – provides 60% to 65% reflection
- Yellow paint – provides 65% to 70% reflection
- Mylar – provides 90% to 95% reflection
- Gloss white paint – provides 70% to 75% reflection
- Flat white paint – provides 75% to 80% reflection

You can use light movers with HID for best results. By using movers, you eliminate the need for plants to grow toward the light.

There are two types of movers – linear and circular.

- Linear movers, as the name suggests, move in a linear pattern (back and forth). These are around 6 feet long and carry a single lamp – most beneficial for narrow and long grow areas.
- Circular movers can carry one, two or three lamps and cover the growth area in circular pattern covering 10 x 10 foot area. These are suitable for growth areas that are wide and long or square.

MAINTENANCE

Every type of hydroponic system has to be clean once in a while. Do it about once a month. When it comes to properly cleaning out a hydroponic system it is simpler than it sounds. Just soak you reservoir in hot water and rinse, then mix 10% bleach and 90% water in a spray bottle and thoroughly spray complete inside and scrub. As for the drippers and irrigation parts just let these soak in a 10% bleach/water mix for 10 minutes then clean thoroughly.

4 WHICH VEGETABLES TO GROW INDOORS FOR SUCCESS

In This Chapter:

- Vegetables that can be grown indoors.
- Seed selection
- Seed Germination
- Plant combinations

Vegetables provide essential nutrients to the human body and are part of a healthful diet and lifestyle. Specific vegetables can be consumed raw – as salads whereas others need to be cooked. Whatever way we consume vegetables, they are tasty and provide immense health benefits.

It is much more fulfilling to grow your vegetables and use them in your daily cooking! Home-grown vegetables not only taste delicious but are also more healthful than the commercially grown crops. If you are health conscious, nothing works better than a bowl of freshly prepared salad from home-grown herbs and plants.

Plants can be Perennial, Annual or Biennial. Perennial plants live for more than two years. Annual plants germinate, flower and die within one year or within the season. Biennial plants take two years to complete their life cycle.

LIST OF VEGETABLES THAT CAN BE GROWN INDOORS SUCCESSFULLY

Salad greens

Spinach – germination time is 6 to 12 days; is a winter annual crop
Watercress – seed germination occurs in 7 to 14 days; is a perennial crop
Arugula – germinates in a week; is both annual and perennial
Mustard – germinates in 5 to 10 days; specific seed varieties sprout in a day!
Lettuce – takes 4 to 8 days to germinate; is a temperate annual or biennial

Herbs

Dill – germinates in a week time; is an annual herb
Coriander – germination time is usually 10 days; is an annual herb
Basil – germinates in 6 to 10 days; is an annual herb
Chamomile – seed germination time is 7 to 14 days; is perennial but grown as annual

Lavender – requires 14 days or more for the first sprouts to appear; is perennial
Mint – germination time 7 to 14 days; is perennial
Tarragon – germinates in 7 to 14 days; you CANNOT grow French Tarragon from seeds
Sage – germinates in one or two weeks; garden sage or common sage is perennial
Thyme – can take 3 to 4 weeks and sometimes more than a month; is perennial

Vegetables

Names	Lighting	Lamp Types (HID)	Favorable Temp	pH range
Beans	High Light	400 / 1000W	Warm	6
Bell Pepper	High Light	400 / 1000W	warm-hot	6
Corn	High Light	400 / 1000W	hot	6
Cucumber	Medium Light	1000W	hot	5.5-6.0
Eggplant	High Light	1000W	hot	6
Melon	High Light	400 / 1000W	hot	5.5-6.0
Onion	High Light	400 / 1000W	hot	5.5-7.0
Peas	Medium Light	400 / 1000W	cool	6-7
Squash	High Light	400 / 1000W	hot	5.5-7.5
Tomato	High Light	400 / 1000W HPS	hot	5.5-6.5

SEED SELECTION

The fruits and flowers that your plants produce are only as good as the seeds you use. It is important that you choose the best seeds for your Hydroponic garden. Here are a few points that may help you select good-quality seeds:

- Before purchasing seeds, learn about the bloom time; some bloom early – in less than a month and others take more than a month.

- Buy your seeds from reputable shops; usually the seed packets contain all the necessary information required to grow the plant.
- Consider environmental factors – do you intend to grow your plants outdoors with ample sunshine / shade or indoors with artificial lighting. Discover how well the selected seeds respond to climatic changes / conditions.
- Do not take the short route – the Internet way! Not all of them are genuine.
- The seeds must not be more than three years old; they should have been stored in a dry cool place but never in a freezer
- The best way to get good-quality seeds is to approach the breeder directly; this might not be always possible and you have to finish buying seeds from a reseller. Ask the reseller for 100% guarantee – most genuine resellers give a guarantee.

SEED GERMINATION

Seeds are the primary source of plant reproduction. You can also transplant soil-grown plants to your Hydroponic system but starting from the seed is the best way to go – you do not have to worry about transplant shock and pests in your plants.

To successfully begin and continue the germination process, there are a few requirements to be met:

- Select a material – Perlite and Rockwool are the most common
- Moisten the material with nutrient solution (dilute the solution to attain half strength)
- Maintain pH of nutrient solution at 6.0
- If you are using Perlite material, sprinkle the seeds on moistened Perlite; cover it with another thin layer of Perlite to keep the seeds moist.
- If Rockwool is your preferred material, cut it into cubes, make a hole in the middle of each cube and soak in nutrient solution. Now drop one seed into the hole of each cube.
- Maintaining ideal humidity, air temperature and root temperature is vital.
- Humidity must be in the range of 70% to 90%
- Air temperature must be around 70° F to 78° F
- Root temperature must be 72° F to 80° F
- Maintain 20W/sq. foot light till majority of seeds begin to sprout.
- Once sprouts appear, increase lighting
- Wait for the 2nd set of leaves to appear then transfer to growing area.
- Remember to over seed by 25% to 50% - not all the seeds will develop into strong plants; some may not germinate at all and others might die soon after germination. Over seeding helps you pick the strongest plants to transfer to your growth area.

- Maintaining correct temperature is important for proper seedlings – this is the step before sprouts appear. You can use incubators, propagation table or seedling heat mats to sustain the right temperature.

PLANT COMBINATIONS

If you are planning to grow more than one crop at a time, there are specific combinations you might want to follow. Specific plants have similar needs – nutrient requirements, germination time, growth stages, and so on. Growing such crops together can help you produce crops of better quality and quantity. Here is a list of crops that have similar needs:

Tomatoes

Tomatoes are the most popular vegetable grown Hydroponically. Most commercially grown tomatoes belong to the indeterminate variety. If you want to grow smaller tomatoes to suit your space requirements, select seeds accordingly.

Tomatoes grow in any kind of Hydroponic system but a Drip system is the best.
Seed germination time is 3 to 6 days and it will take 100 days before you can see your tomato plants bear fruits; they usually continue to produce fruits for a year.
Similar crops: Peppers and Cucumbers

Lettuce

An all-time favorite among Hydroponic growers. Leaf lettuce is a better choice than head lettuce.

Nutrient Film Technique is the best system to grow Lettuce; you can also grow it in an Ebb and Flow or drip feed system.

Lettuce seeds germinate in 4 to 8 days and can be harvested in 35 to 45 days; to maintain a continual supply of lettuce, seed them every few days.

Similar crops: Spinach, Basil and leaf crops

Carrots

Carrot is a root crop that grows well in Perlite; so will any other root crop like radish and beets.

Roots crops require a large growth bed to grow and develop fully.

It takes 6 to 10 days for the seeds to germinate and 2.5 to 3 months to harvest.

Similar crops: Beets, Leeks, Radish

Cucumber

Cucumbers are long-term crops and continue to yield fruits up to 6 months. European seedless varieties are easier to grow Hydroponically. cucumbers need large space and supports to grow.

Drip system with Rockwool or Perlite as the growth material is your best choice.
It takes 3 to 5 days for germination and 6 weeks to begin harvest; thereafter you can continue to harvest for six months. To promote continual growth of cucumbers, harvest them regularly.

Similar crops: Peppers and Tomatoes

Basil

Basil is a herb that grows between 12 to 18 inches tall. Buds and flowers must be pruned regularly to encourage continual growth.

It takes 6 to 10 days for the Basil seeds to germinate and will produce fresh leaves for 3 to 4 months. After 3 to 4 months, the old basil plant must be replaced with a new one.

Similar crops: Spinach and Lettuce

Beans

You can harvest high yields from bean plants. An Ebb and Flow system works well with Perlite or expanded clay pellets.

Seed germination takes 3 to 8 days and you can start harvesting in 6 to 8 weeks. You can continue harvesting for 3 to 4 months.

Similar crops: Peas

Radish

Radish is also a root crop similar to carrots. Radish grows well in a system with a deep bed. Popular growth systems are an Ebb and Flow system or a drip system with Perlite or LECA as growth materials.

Seed germination is quick – it takes 2 to 5 days. You can start your first harvest in 30 to 40 days.

Similar crops: Leeks, Beets and Carrots

Broccoli

Broccoli belongs to the cabbage family and likes to grow in cooler temperatures. So, if you want to grow this vegetable, make sure that your temperature settings are cooler.

Seed germination takes 5 to 6 days at a temperature of 770 to 950 F and at much lower temperature of 500 to 590 F, it takes between 10 to 20 days. You can begin harvesting Broccoli in about 4 months.

Similar crops: Cauliflower, Cabbage

Peppers

Peppers come in variety of colors and flavors. You can grow both hot and sweet peppers. Use a drip system or an Ebb and Flow system to grow these vegetables.

Pepper plants grow tall – using a growth material that provides the required support is important; you can use Rockwool for seed germination and later use Perlite mixed with Vermiculite and fine gravel.

It takes 10 to 14 days for seed germination and you can harvest in the 4th month.

Similar crops: Tomatoes and Cucumbers

Spinach

Spinach grows well in a NFT system or an Ebb and Flow system. You can use Rockwool for seed germination; care must be taken to provide enough growing space for these plants otherwise you risk choking them. The usual space allowed between two plants is 20 sq inches.

Seed germination requires 6 to 12 days and the first harvest begins only by the end of 2nd month (approx 50 to 60 days).

Similar crops: Basil, Lettuce

HARDINESS ZONE INDEX

This index specifies the climatic conditions in which a plant can survive; it also includes the minimum temperatures that the plant can withstand. For example a plant with hardiness to zone 9 can withstand temperature down to -7o C

USDA Hardiness Zones

Hardiness Zone	Average Min Temp (F)	Average Min Temp (C)
1	Below -50° F	Below -46° C
2a	-45° F	-43° C
2b	-40° F	-40° C
3a	-35° F	-37° C
3b	-30° F	-34° C
4a	-25° F	-31° C
4b	-20° F	-29° C
5a	-15° F	-26° C
5b	-10° F	-23° C
6a	-5° F	-20° C
6b	0° F	-18° C
7a	5° F	-15° C
7b	10° F	-12° C
8a	15° F	-9° C
8b	20° F	-7° C
9a	25° F	-4° C
9b	30° F	-1° C
10a	35° F	2° C
10b	40° F	4° C
11	Above 45° F	Above 7° C

US Hardiness Zones

City	Zone	City	Zone
Albuquerque, New Mexico	7	Oklahoma City, Oklahoma	7
Anchorage, Alaska	4	Omaha, Nebraska	5
Atlantic City, New Jersey	7	Orlando, Florida	10
Atlanta, Georgia	8	Owensboro, Kentucky	6
Baltimore, Maryland	7-8	Philadelphia, Pennsylvania	6-7
Barnstable, Massachusetts	6	Phoenix, Arizona	9
Boston, Massachusetts	6	Pierre, South Dakota	5
Burlington, Vermont	4	Pittsburgh, Pennsylvania	6
Chicago, Illinois	5–6	Portland, Maine	5
Charlotte, North Carolina	7–8	Portland, Oregon	8
Cleveland, Ohio	5–6	Providence, Rhode Island	6
Dallas, Texas	8	Raleigh, North Carolina	7-8
Denver, Colorado	5	St. Louis, Missouri	5-6
Detroit, Michigan	5–6	Salt Lake City, Utah	6-7
Fairbanks, Alaska	1	San Antonio, Texas	8-9
Honolulu, Hawaii	11	San Diego, California	10
Houston, Texas	8-9	San Francisco, California	8-9
Las Vegas, Nevada	8	San Jose, California	8-9
Los Angeles, California	10	Seattle, Washington	7-8
Memphis, Tennessee	7	Tampa, Florida	9
Miami, Florida	10	Tucson, Arizona	8
Minneapolis, Minnesota	4	Tulsa, Oklahoma	6-7
Nashville, Tennessee	6-7	Washington, D.C	7-8
New Orleans, Louisiana	9	Wichita, Kansas	6
New York, New York	6-7	Newark, New Jersey	6
Wilmington, Delaware	7	Trenton, New Jersey	6-7

5 GROWING VEGETABLES AND HERBS HYDROPONICALLY

In This Chapter

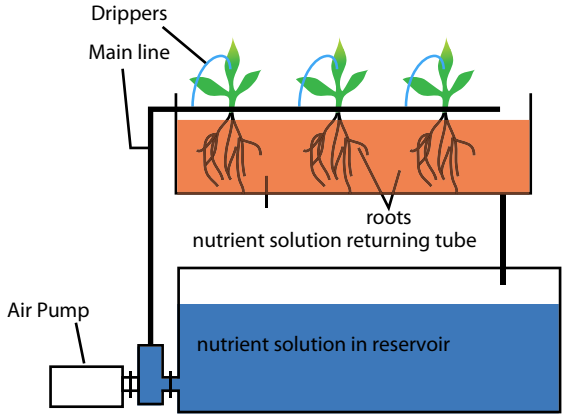
- Constructing a drip feed system
- Maintaining a drip feed system
- Growing herbs the hydroponic way.

Now that we know the basics of Hydroponics, it is time to build our own Hydroponic system and learn to grow tomatoes in your system! Even though there are many Hydroponic systems, we are going to learn to grow tomatoes using a 'Drip System', commonly used to grow bigger plants.

CONSTRUCTING A DRIP-FEED SYSTEM

A drip feed system has a dripper for each plant provide nutrients. Because the nutrient solution is fed directly to roots, they do not have to grow long in search of nutrients. Parts of a drip feed system are:

1. Drip feed tank
2. Drain System
3. Pump
4. Drippers
5. Growth tray
6. Pipe



Step 1

Drill a hole at the bottom of growth tray that will hold growth material and plants. Attach a pipe to this hole that runs into the nutrient tank. Seal the edges of the hole using silicon sealer. This pipe helps drain excess nutrient solution back to the nutrient tank.

Step 2

Attach the pump and the principal tube carrying nutrient solution.

Step 3

Now attach the dripper tubes that provide nutrient solution individually to plants.

Step 4

Fill the growth tray with growth material (your choice) and place your plants. Allow enough spacing between plants.

Step 5

Switch on the pump and ensure that the drippers drip only the required quantity of nutrient solution. Too much of solution causes plant decay.

The next step is seed germination (discussed in the previous chapter) followed by correct lighting.

MAINTAINING YOUR DRIP FEED SYSTEM

- Always start your drip feed system with a full container of nutrient solution.
- Before topping up your container, add a gallon of pH adjusted water; allow your system to run for 5 minutes.
- Now, completely drain the system.
- Fill your container with a fresh batch of pH adjusted nutrient solution.
- Every 2 to 3 months, clean your drippers and pump.
- After harvesting, clean your grow tray and air-dry.

GROWING HERBS THE HYDROPONIC WAY

Almost all of us would love the thought of using freshly plucked herbs in cooking. Even though you can always grow these herbs in soil, you can reap a healthier herb if grown Hydroponically. In the following pages, you get to learn more about growing some herbs Hydroponically.

Basil

The best system to propagate growth is NFT – transfer the seedlings to NFT when seedlings are 1 to 2 inches long. Seed germination takes 7 days; provide a spacing of 9 to 12 inches between plants. You can use vermiculite, soil-less mixtures, Rockwool and coco-peat. Basil thrives and continues to grow in ample sunlight and needs 11 hours of daylight. Do not harvest basil on short days because it is susceptible to diseases. Most

common causes of disease are from Aphids and Pythium. USDA hardiness is not applicable to Basil.

Chamomile

Chamomile is an annual herb that has small white flowers; these flowers are added to tea to give a distinct flavor and induce medicinal properties. Chamomile seeds need light to germinate and usually take 7 to 14 days for germination. These herbs grow to a height of 20 to 30 inches and do well with a spacing of 6 inches between plants. Potential pests are Aphids and Mealybugs. USDA Hardiness is annual.

Chervil

This herb belongs to the Parsley family and is mainly used as a culinary herb. This herb thrives under cool temperature (700 to 750 F); avoid exposing it to direct sunlight. Germination time for Chervil is around a week; transplant the seedlings to NFT when the first true leaves appear. Spacing between plants must be maintained at 1 inch and you can begin to harvest in a month. Chervil is prone to Aphids especially during warm days.

Cilantro

Cilantro or Coriander belongs to the Parsley family; cilantro tastes more like parsley but with a citrus twist. These plants yield seeds that are used in various spice mixtures, liquors and confectioneries. The leaves can be used as a culinary herb. Cilantro grows well in sunlight; you can use fluorescent lights or HID lights. Seed germination takes about 10 days and the plant can grow up to 2 feet tall. Pests that can attack cilantro are Aphids, whitefly, mites and thrips. USDA Hardiness is Annual.

Dill

Dill too belongs to the Parsley family and is an annual / biennial herb. Dill seeds are used in pickles and the herb itself is used as a culinary taste enhancer. These plants usually reach a height of 24 to 36 inches and must be spaced 12 to 15 inches apart. It takes around 10 days for the seeds to germinate and the plant grows well in full sun. Using HID lights can do the trick indoors. Care must be taken not to over-water Dill plants; USDA hardiness is not applicable to Dill, and it can be affected by powdery mildew and aphids.

Lavender

A flowering plant that belongs to the mint family. Lavender flowers, when dried give out a pleasant aroma; these flowers are widely used in aromatherapy oils and perfumes. Lavender grows to a height of 18 inches; the spacing must be 20 to 24 inches between plants. Seed germination can take between 10 to 28 days. Lavender needs enough sunshine; mimic the light using HID lights. Lavender can be attacked by white-fly, spider mites, Mealy bugs and scales. USDA Hardiness is 5a to 9b.

Lemon Balm

This belongs to the mint family and is known for its soothing properties. It is considered a 'soothing herb'. Lemon Balm grows well under partial sunlight and propagates through seeds and vegetation. Seed germination takes 5 days and 3 to 4 weeks for root growth. Transplant the seedlings when they are around 2 inches tall. Lemon Balm is sensitive to White-fly attack, Spider Mite and Thrip. USDA Hardiness zone is 4a to 9b.

Marjoram

These are perennial herbs grown as annuals; there are 2 varieties – wild and sweet. Sweet Marjoram is used as a culinary herb. It grows to a height of up to 36 inches and the spacing between plants must be 15 to 18 inches. Germination time is 10 to 15 days; these herbs grow well under sunlight. Lack of light or poor lighting arrangements will lead the plant to perish to fungal infections. Marjoram is sensitive to a variety of fungal infections and white-fly attacks. USDA Hardiness is 6b to 11.

Oregano

A perennial herb and is also called 'pot marjoram'. Oregano, a Mediterranean herb grows up to 18 inches high; spacing between plants must be 12 to 15 inches. The seed germination time is 8 to 14 days and takes around 4 weeks to begin harvest. This herb prefers to grow in full sunlight; do not overcrowd the leaves else it leads to decay and infections. You must provide extra lighting when daylight is shorter than 11 hours. Oregano is sensitive to fungal infections and attacks from white-fly, mites and leaf miner. USDA Hardiness is 5a – 9b.

Parsley

A biennial herb that is grown as an annual. Parsley has many varieties – curly leaf, fern leaf and rooted. You can grow Parsley in full sunlight but it can grow in partial shade too. Using fluorescent lamps for indoor cultivation is sufficient. These plants reach a maximum height of 18 inches; space the plants 12 inches apart. Seed germination is slow in Parsley – usually takes 3 weeks for the seedlings to appear. There are not many diseases associated with Parsley; however, they can be attacked by Aphids, spider mites and white-fly. USDA Hardiness is 5a – 9b.

Rosemary

Rosemary has many uses; it is used as a culinary herb and in medicine. This herb thrives in well drained material and requires occasional watering. Rosemary has a slow growth rate but can last for years with proper winter protection. They can grow to a height of 6 feet; seed germination takes around 3 to 4 weeks. The growth rate slows when the daylight falls below 11 hours. Rosemary is prone to fungal infections such as Powdery Mildew and attack from Mites. USDA Hardiness is 7a to 10b.

Sage

Sage is a perennial shrub that is used both for culinary and medicinal purposes. Sage

needs enough sunshine and a minimum of 10.5 hours of daylight. Shorter days affect the growth of this shrub. Seed germination takes around a week, and grows up to a height of 36 inches. Plant spacing must be 24 inches apart. During winter, you can use supplemental fluorescent lighting 14 hours/day to ensure good growth. Sage is sensitive to infections but can usually overcome them; it is prone to attacks from Mites and White-fly. USDA Hardiness is 4a – 11.

A NOTE ON CULTIVATING HERBS FOR COMMERCIAL USE

Herbs are always in demand – for culinary uses, medicinal uses, aromatherapy, and so on. Once you start growing herbs, it almost becomes an addiction! The taste and aroma of freshly plucked herbs from your garden is indeed fulfilling and rewarding. As you gain momentum with your herb gardening, you soon realize the herbs that grow well and those that do not. You might have your favorites too. Once your garden is always full of herbs and your neighbors start borrowing fresh herbs from you, it is time to take your hobby to the next level; going commercial. Some of you might be intimidated by the thought of growing herbs as a business yet others might be thrilled. Despite how you feel about it, you must always start with market research.

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Lemon Balm	Melissa officinalis
Marjoram	Origanum majorana
Oregano	Origanum vulgare
Parsley	Petroselinum
Rosemary	Rosmarinus officinalis
Sage	Salvia officinalis

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6 TROUBLESHOOTING

In This Chapter

- PH related problems
- Pest
- Water
- Overuse of nutrients
- Distance to light-sources
- Root bound
- Algae
- Mold
- Fungus

Growing with hydroponics can be somewhat complicated enough with just the system itself, but when problems arise with your plants this could become a big problem. Here we will go though some of the more common problems that can hold your grow back, so that in the future you will be able to correct and avoid these pitfalls.

PH RELATED PROBLEMS

If you are properly feeding and caring for your plants and you notice some ill signs, then you problem is more than likely PH related. Here are some signs of PH related symptoms: burning of the leaves even when properly fed nutrients, leaves twisting and stop growing all together, and yellow spot. A PH problem can easily be solved by testing the PH of the water solution with a PH meter, and then adjust according with PH adjustor found at almost any plant store. PH related problems are among the most easily to recognize and treat. When growing with hydroponic systems a PH tester is a must and all hydroponic growers should always have at least one.

PEST

Pests are mostly invited! True – because it is rare to get pests in an indoor garden unless

the plant came from outdoors. Anyway, the question here is not how you get pests but how do you tackle them.

Table of Pests and Predators:

Type	Consequences	Latin Name
White-fly	White-fly lays eggs on the underside of leaves leading to shiny sticky leaves	Parasitic wasps – Encarcia Formosa
Thrips	Small yellow speckles on leaves; because of the small size of thrips, they are often only noticed after the damage	Amblyseius cucumeris and Orius laevigatus
Aphids	Fruit contamination and virus carrier	Aphidius colemani and Aphidoletes aphidimyza
Red Spider Mites	Destroy plants by feeding on plant tissue	Phytoseiulus persimilis
Beet Armyworm	Destroy tomatoes	Hyposoter exiguae

There are many different kinds of pests that can completely ruin your crop, it is imperative to know how to spot a pest problem and if you have one and how to eliminate it. I recommended checking every plant really well at least 1-2 times a week. Especially underneath the foliage, this is where pests usually thrive. It is relatively easy to spot any kind of bug infestation, The usually signs are little holes on the leaves, pieces of leaves missing, webs seen from leaf to leaf, and obviously the bugs themselves being seen. If checked thoroughly and regularly you can spot any bugs on your plants and deal with accordingly before it becomes a problem.

There are numerous ways to deal with this problem. Among The most effective are purchasing an organic pest control spray for plants, can be found at almost every plant nursery and grow store... Another method is spraying your plants down with a 10-20% neem oil/water mix in a spray bottle and Spray the entire plant down. And a really good home remedy that works very well is mixing a dab of plain dish soap in a spray bottle, fill with water and spray thoroughly, making sure underneath the leaves are adequately sprayed. Come back in 1-2 hours and rinse off with plain water.

You can also use insecticides and pesticides to control and tackle the pest problem – it is not the best solution hough. First, all pesticides are toxic (despite whatever the manufacturer claims) and second, pests develop a tolerance toward pesticides. So, what do we do?

We can introduce other insects that are predators of our pests. It may sound crazy to you but that is how the food chain works in the real world. The population of these predators depends on food availability; so as your pests dwindle in number, so do your predators.

You can also use insect traps (sticky papers); you can buy them or make them. To make them, cut out cardboard strips, paint them with any color you want; allow them to dry completely. Now, apply Vaselineor any petroleum jelly; use these strips for every 3 to 4 sq. feet of garden area.

WATER

When plants are over watered they will quickly start to develop root rot, which can quickly spiral out of control before you may even know there is a problem. This could lead to a plant to stop producing new leaves. These are the main signs of overwatering: wilting of the leaves and roots will become brow and mushy and stick a bit. Signs of under watering: leaves will start to drop dramatically and eventually dry up. To correct these problems simple give less or more water. A little tip to remember is that it is always better for a plant to receive less water than more.

OVER USE OF NUTRIENTS

This is maybe the most common problem when using hydroponics, the signs include: “burning” of the leaves, leaves cupping inwards, and sometimes a copper color spotting will appear. When this happens simply change out your reservoir and use straight water for a few days then re-apply nutrients and check PH levels. When using hydroponic nutrients you must be very careful when measuring the amount to put into your reservoir, follow the recommended feeding schedule for your nutrients exactly, or less. All nutrients should have directions of use on the label somewhere.

DISTANCE TO LIGHT-SOURCES

This common problem is can be spotted by the outer parts of your leaves closest to the light turning a brown color and eventually warping. If your hand gets hot when you put under the light, then you know it’s too close and move up accordingly. Now on the other hand, when plants are too far from a light source or the light output is not enough the symptoms are very obvious. Your plants will tent to “stretch” towards the light, basically bending and elongating itself. Lights being too far will also cause very slow growth and eventually cause growth to stop completely, even if you would move your plants into abundant light they would not recover.

ROOT BOUND

This is spotted by slow growth and roots appearing to come from the top of your hydroponic system. This can easily be detected and corrected by simply making sure you hydroponic system has enough room for roots and checking roots weekly to make sure they have more than enough space. You would be surprised on how fast they can grow and expand.

ALGAE

This is common among almost all hydroponic growers, and can be seen inside of tubing and all inside of your reservoir. The cause of this is sunlight exposure. To prevent this problem try to shield as much as your system and its irrigation tubing, as possible with a reflective material. Reflective tape does very well at this. Another way to prevent algae growth is too regularly clean your hydroponic reservoir and tubing at least every few weeks. Doing this and securing any light leaks will ensure you will not develop algae.

MOLD

Mold is usually a common problem when growing indoors is that it is closed environment. Mold is usually caused by too much moisture in the air, and/or not enough air circulating throughout your growing area. The signs are a white substance build up on your growing medium and on the plant itself. When you have mold the first thing to do would be to check the humidity with a hydrometer and check if the humidity levels are normal. Next I would check and see if your ventilation fans are properly circulation air, it is always good to have at least 1-2 fans for exhausting air out the room, 1-2 fans drawing in fresh air, and 1-3 fans blowing directly on your plants. Make sure all these requirements are meet and your mold problem should be a thing of the past.

FUNGUS

Fungi can grow at any time in anyone's garden without any signs or anything beforehand. It can cause serious problems for you plants such as producing diseases, rust, and mildew. The signs of fungi are immediately apparent as being whitish spots, leaves appearing to have white powder on them and leaves turning brown and soft. There are basically 2 different types of actions to deal with this: non-organic fungicides stated as "safe" but contain harmful chemicals to humans and animals. And there is organic home remedies'. Try using some of these simple methods get rid of fungi. Neem air is a great deterrent of fungus. The only thing is that you have to keep reapplying every other day till the problem is gone. Another great idea is a coffee solution mixture, Do 1 part all black coffee to 10 parts water. Mix all this in a bottle and spray. One more solution that is proven to have results is one tablespoon of baking soda per gallon of water, a dab of dish detergent and just a drop of vegetable oil. Spray this solution thoroughly over your plants.

7 GOING COMMERCIAL

In This Chapter

- Key requirements
- Plant culturing
- Cultivating herbs for commercial use

Harvesting crops from your Hydroponic garden is indeed a fulfilling moment. As you gain experience, you can try new methods or try to grow other crops. You might even extend your garden to increase the quantity. Even before you realize, you might be giving away your home-grown tomatoes, cucumbers, peppers, and such to your neighbours.

KEY REQUIREMENTS

Harvesting crops from your Hydroponic garden is indeed a fulfilling moment. As you gain experience, you can try new methods or try to grow other crops. You might even extend your garden to increase the quantity. Even before you realize, you might be giving away your home-grown tomatoes, cucumbers, peppers, and such to your neighbours.

In the US, tomatoes are the most popular Hydroponic vegetable followed by cucumber and pepper. So, if you are thinking about taking your hobby to the next level – business – here are a few pointers to consider:

- To begin with, a small Hydroponic farm – around 1 acre is required.
- High-quality produce require high-quality nutrient; these crops need to be grown free of herbicides and pesticides.
- You must monitor the pH and temperature frequently every day and record the readings.
- Depending on the plants' growth stage, you must change the lighting and nutrient solution

- You must know plant culturing; it includes clipping, sucker pruning, cluster pruning and leaf pruning (discussed in the next section)
- Marketing your produce – you can first try to sell at the farmers' market or through a cooperative network.
- You can also try selling directly to grocery stores.

PLANT CULTURING

Plant culturing is a part of commercially grown crops; they help produce the best-quality crops. Most tomato growers plant the seeds in a small space. Once the seedlings appear, they are transferred to the greenhouse. It takes around 3 ½ months for the first harvest; it continues for 8 to 9 months.

Clipping

Tomato plants can grow as tall as 1 foot weekly. As the plants grow, they need to be supported. Primary support wires are strung above the plants; a small string is tied to the tomato plant and clipped onto the principal wire. This process is called clipping and has to be done weekly.

Sucker Pruning

Around the 4th or 5th week, tomato plants develop side branches at every leaf axial. Usually greenhouse plants are groomed as a single stem; hence the side branches must be pruned weekly. It is done by grasping the sucker, bending it sideways then backward.

Cluster Pruning

When you see the first tomatoes on your plant, it is time for you to prune the weakest ones; this helps the remaining tomatoes grow into large tomatoes. Usually the cluster is kept to 3 or 4 depending on the type of tomatoes and season. Cluster pruning is done weekly.

Leaf Pruning

The lower leaves of a tomato plant are removed as the plant matures. This helps the plant develop new leaves at the top.

Miscellaneous Greenhouse jobs

Apart from the above jobs, you must also help the plants to pollinate. In outdoor gardening, nature provides way for pollination. However, in greenhouse cultivation, pollination must be induced. You can use pollination wand to propagate pollination.

Touching an open flower with the wand can provide efficient pollination. If you are not using pesticides, bring a bumble-bee. They are cost effective and more efficient than human pollination.

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